

**REMARKS**

Claims 1-20 and 22-23 are pending. Claim 21 was withdrawn from examination because it is directed to a non-elected invention. Applicant has cancelled claim 21 without prejudice. Applicant reserves the right to file a continuing application on all non-elected inventions at a future date.

Claims 1, 10-16, 19, 22, and 23 have been amended. Support for the claim amendments can be found in the specification at page 9, line 30 – page 14, line 29, and the original claims. Accordingly, applicant respectfully submits that this amendment does not add new matter.

Applicant requests reconsideration in light of the following remarks

**Response to Restriction of Claim 21:**

Applicant appreciates that the patent office has found claim 21 to be independent and distinct. In order to expedite prosecution, applicant has cancelled claim 21. Applicant has amended claim 22 to place it in independent form, and claim 23 has been amended to depend from claim 22.

In addition, applicant reserves the right to file a continuing application on all non-elected inventions at a future date.

**Claim rejections under 35 U.S.C. § 112, second paragraph:**

Claim 1 has been amended to remove the term “composition.”

Claims 10-16 have been amended to recite that “the” DUV wavelength includes the recited wavelength ranges.

Claim 19 has been amended to recite that the IR auto-focus system is “in optical communication with the objective,” thus providing the structure of the IR auto-focus system as providing the IR wavelength that is supplied to the objective.

Accordingly, applicant requests reconsideration of the outstanding 112, second paragraph rejections.

**Claim rejections under 35 USC § 112, first paragraph:**

Claims 1-20 and 22-23 stand rejected under 35 USC § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art ... to make and/or use the invention. Applicant respectfully requests reconsideration of the enablement rejection based on the following.

In the final Office Action dated January 10, 2002, see page 3, the patent office states that the specification fails to teach why a microscope objective with quartz and fluorite lenses can focus both ultraviolet (UV) light and infrared (IR) light at the same focal point. While applicant respectfully disagrees with the enablement rejection, and for at least the reasons set forth in applicant's previous response dated November 9, 2001, applicant provides the following further information that is known by one of ordinary skill in the art, and that when combined with the teachings of the specification, enables one of skill in the art to practice and/or make the claimed invention without undue experimentation. See MPEP 2164.01 ("The test of enablement is whether one reasonably skilled in the art could make or use the invention from the disclosures in the patent coupled with information known in the art without undue experimentation.").

1. **Dispersion**

As an initial matter, concerning dispersion, the patent office states, in the final rejection dated January 10, 2002, that: "It is generally understood in the art that lens materials have dispersion effect that causes the ultraviolet (UV) light and infrared (IR) light, having very different wavelengths, to refract through the lenses in very different direction." While this statement is generally true, it is also known in the art, per se, by one of ordinary skill, that for a simple (e.g., two) lens system, dispersion (also referred to herein as "chromatic aberration") can be compensated by using lenses of different materials. For example, applicant has attached a copy of the "Optics" textbook by Hecht and Zajak, Addison-Wesley Publishing, 1974 edition, see especially pages 186-192, which explains in detail how dispersion can be compensated by an achromatic lens system.

As shown on page 188, Fig. 6.34, two different lenses of different dispersion and refractive powers can be used to focus red and blue light at the same focal point. In

particular, Fig. 6.34 shows a left lens made of Crown glass that has a greater and positive refractive power (and respectively smaller dispersion). The right lens is made of Flint glass and has a smaller and negative refractive power (and respectively greater dispersion). The different dispersions of both lenses were chosen in order to achieve a dispersion of the two-lens-system equal to about zero. The equations showing how this dispersion compensation can be achieved are detailed in the attached Hecht excerpt, for thin achromatic doublets and separated achromatic doublets. In addition, page 191 shows several examples of Crown/Flint glass combination achromatic doublets.

In summary, the Hecht excerpt shows a chromatic correction that can be achieved to combine the foci of the two wavelengths (here, red and blue) at the same focal distance in respect to the front lens. To achieve this chromatic correction, an appropriate ratio of the refractive powers of the lenses is chosen.

Accordingly, while it is not an expected result that the UV and IR wavelengths can be focussed to the same focal point, for at least a simple two lens system, it is within the knowledge of a person reasonably skilled in the art that two thin lenses of different composition could be combined to result in the overlapping of foci for red and blue light, or other wavelengths, based on the equations shown in Hecht.

## 2. Expanding to a microscope objective

Prior to the present application, it was not known or obvious that a DUV-capable microscope objective could be made, wherein the objective has an IR focus for an IR wavelength  $\lambda_{IR}$  760 nm at the same focal point as the DUV focus at  $\lambda_{DUV}$ . The present specification shows, in quite substantial detail (see e.g., Figs 5-8 and 20-22), that by choosing an appropriate ratio of refractive powers of all lenses, a microscope objective can have a same focus for IR and DUV light. More importantly, by knowing the appropriate starting system, here the recited penultimate lens combination, an optical designer of ordinary skill using known techniques is able to make the claimed microscope objective.

Based on the general knowledge discussed above, and the additional details provided below, applicant submits that the present specification is enabling to one of skill in the art to practice and/or make the claimed invention without undue experimentation. Applicant has additionally attached several Figures to further illustrate the remarks below.

a. Aberrations, Distortion

As is known, most optical systems are designed to image an object scenery into an image plane like e.g. with a photographic camera lens. However, there is a difference with microscopy: with microscope objectives it is similar except that the object to be imaged is of very small extension and one wants to image it with a large magnification to be able to see even the smallest details.

Marginal magnifications can be achieved by a magnifying glass comprising just one single lens. When using such a magnifying glass it becomes immediately apparent that there are image aberrations: the image is (apparently) sharp only at the center and becomes more and more blurred outside. With a single lens magnifying glass of higher magnification even the center part of the image would be blurred.

The reason for this blurring is that (in general) all the light rays emerging from one point of the object do not again intersect in one single point in the image plane as is shown in the attached Fig. 1.

The offset  $\Delta y'$  of a ray intersection in the image plane from the ideal intersection point is called *lateral aberration*. In practice, there are not only rays in the drawing plane (*meridional plane*) of attached Fig. 1 but also in planes perpendicular to it (*sagittal planes*), i.e., there are also  $\Delta x'$  lateral aberrations. As the  $\Delta y'$  and  $\Delta x'$  are different for the different light rays, there are in general at least two different lateral aberrations  $\Delta y'$  and  $\Delta x'$  associated with each single ray. Just by bending the lens, i.e., by changing the curvatures of the lens surfaces in a proper way, one can achieve an improvement as is shown in attached Fig. 2.

However, even with a simple magnifying glass it is not practical to view just one single point of the object located on the *optical axis*, which is the line joining the centers of curvature of the lens surfaces. One actually wants to have a finite field of view, i.e. some *off-axis* extension of the image from its center point on the optical axis. Tracing off-axis bundles through the lens as in Fig. 2 reveals that not only the aberrations become larger (and asymmetrical which is called *coma*) but also that the point of least blur is no longer in the same image plane as for the on-axis image point. This off-axis aberration is called *field curvature* (while the on-axis aberration shown in Fig. 1 is called *spherical aberration*). As mentioned above, for any specific object point there are also rays which propagate in planes

perpendicular – *sagittal planes* -- to the drawing plane (*meridional plane*). For those sagittal rays, the point of least blur is again in a different image plane as compared to the drawing plane meridional rays. This *focus difference* is called *astigmatism*.

In the reality of a three dimensional space, the blur in the image of an off-axis object point is actually a superposition of the following: spherical aberration, coma, field curvature, and astigmatism - and each ray contributes with a different amount.

There is an additional aberration which does not cause an image blur but an image distortion. The distortion makes straight lines in the object to become curved and bent outwards (*pin cushion distortion*) or inwards (*barrel distortion*).

In addition, all of these aberrations look different and get different figures with different colors (or wavelengths) of light. For example, for a lens like in Fig. 1, the best image plane for blue light is closer to the lens than that for red light (see e.g., Fig. 3, top right region) what is called *longitudinal chromatic aberration*. Furthermore, the image in blue light is larger than that in red light: called *lateral chromatic aberration*. The change of spherical aberration with wavelength is the so called *chromatic variation of spherical aberration* or in short *spherochromatism*. In the same way there is a *chromatic variation of coma, astigmatism*.

For an optical designer, it is also important to note that the sign and the magnitude of the aberrations depend approximately on the sign and the magnitude of the lens parameters. By a skillful combination of multiple lenses with suitable radii of curvature, thicknesses, air spacings and refractive indices, one can therefore compensate the specific aberrations introduced by the individual lens elements or refracting surfaces.

b. Optical Design, in General

A known task of optical design is to determine the most appropriate set of multiple lens elements which meet the imaging requirements needed. This task of optical design is based on and guided by many physical laws, physical theories and mathematical procedures. See e.g. the simple achromat lens system described in the Hecht excerpt.

Closed algorithms are known for very simple and basic cases like the one of attached Fig. 2, which is the *lens of best shape*: It can be shown that for specified figures on focal length  $f'$  of the lens object to lens distance  $a$  and refractive index  $n$  of the optical glass, the

*spherical aberration* of a single lens is *minimized* if the two radii of curvature  $r_1$  and  $r_2$  are calculated by:

$$r_1 = f' \cdot \frac{2n^2 + 2n - 4}{4 \frac{f'}{a} (n^2 - 1) + 2n^2 + n}$$

$$r_2 = f' \cdot \frac{r_1(n-1)}{f'(n-1) - r_1}$$

However, even for this simple case, both formulas are valid only for the approximation of a lens with zero thickness (*thin lens approximation*). In practice, both radii have to be adjusted for the finite thickness of a real lens. When comparing the ray paths and ray intersections of the biconvex lens in attached Fig. 1 and that of the “best shape lens” of attached Fig. 2, one can see that the improvement is marginal.

A similar situation holds for the *chromatic aberration*. As mentioned above, the focal points for different wavelengths are at different locations along the optical axis. For correcting the *longitudinal chromatic aberration*, i.e. to bring both focal points together at one single point, one needs two lenses, one converging (positive) lens and one diverging (negative) lens of proper optical glasses. As discussed in the Hecht excerpt, this combination is called an achromatic doublet or achromat (see attached Fig. 3 (a)) and the condition for it is

$$\frac{f'_2}{f'_1} = -\frac{\nu_1}{\nu_2} \quad (1)$$

where  $\nu$  is the so-called *Abbe* number which is a measure for the dispersion of the optical glass, i.e. the change of refractive  $n$  with wavelength  $\lambda$ . As above, this also is only an approximation and is valid only for rays close to the optical axis.

The achromatic correction is shown by the ray fans for blue light and red light at the lower part of Fig. 3(b). For better visibility the fans have been traced for image points slightly above (blue) and below (red) the optical axis. Here, the focal points are at the same position along the optical axis, i.e. there is one single image plane for both wavelengths. The ray fans at the upper right side have been traced for a doublet of identical geometry as that of the achromat in Fig. 3(a), but for two optical glasses which *violate* the dispersion condition of equation (1). Accordingly the focal (image) planes for both wavelengths do not coincide.

However, for more complicated optical system designs, there may not be, e.g., a closed algorithm to come from the specifications of the imaging performance directly to the optical system layout and the optical design parameters (lens curvatures, thicknesses, etc.). It is apparent to one of ordinary skill that for non-trivial optical systems and imaging requirements, many aberrations are to be corrected, which calls for many lenses. From aberration theory, the optical designer knows that multiple lenses will do a better job than a single one. It is now the optical designer's choice to go with two, three, (or more) lenses.

Because, *a priori*, an optical designer may not know exactly how many lenses to ultimately use, an optical designer may choose to utilize a known optimization program or numerical analysis technique. The typical mathematics behind such known programs are as follows:

Lens parameters like radii, refractive indices, etc., are considered as *independent* variables  $\rho_i = 1 \dots I$ . The aberrations  $a_j, j = 1 \dots J$  are the *dependent* variables, i.e. each of the aberrations  $a_j$  depends on or is a function of *all* of the design parameters  $\rho_i = f_i(\rho_1 \dots \rho_I)$ . As a result:

$$a_1 = f_1(p_1, \dots, p_I)$$

$$a_2 = f_2(p_1, \dots, p_I)$$

$$a_3 = f_3(p_1, \dots, p_I)$$

$$a_I = f_I(p_1, \dots, p_I)$$

In short form this is written as:

$$\vec{a} = \vec{f}(\vec{\rho})$$

where  $\vec{a}$  is a vector in the I-dimensional aberration space and  $\vec{\rho}$  is a vector in the J-dimensional *parameter space*.

For each individual single lens element, one has (at least) six independent parameters  $\rho_i$ : the radius of curvature of the first refracting surface, the thickness of the lens, the refractive index of the optical glass, the dispersion of the optical glass, the radius of curvature of the second surface, and the distance of this surface to the first surface of the next lens element. For an example sophisticated optical system comprising 10 lens elements, a total of 60 independent system parameters would result. It would also be anticipated that a change of

the distance between two lens elements in a real world optical system would occur. In terms of the mathematics described above, this change is equivalent to a move from one point to another point in an abstract 60-dimensional parameter space.

With the aberration space, it is very analogous: each aberration vector  $\vec{a}$  represents a specific point in the I-dimensional aberration space and accordingly a specific status of aberration correction or image performance. In a typical optical design task, the dimensionality of the aberration space is of about the same order as that of the parameter space- it may be lower or it may be higher, depending on the type of the optical system and the imaging requirements.

The ideal target of the optical design is getting all of the  $a_i$  to zero - which for practical cases is not always possible. Thus, the optical designer of ordinary skill would try to make all the absolute values of  $a_i$  as small as possible, i.e. to *minimize* the  $a_i$ . This is equivalent to the requirement that the sum of the absolute values of the  $a_i$  or the sum of the squared  $a_i$ , (i.e. of the  $a_i^2$ ) becomes as small as possible. However, for different types of aberrations - e.g. spherical aberration and longitudinal chromatic aberration - the same absolute figures for the corresponding  $a_i$  may contribute by a different amount to the overall image performance. To account for this, it is appropriate to operate with *weighted* aberrations, i.e. to multiply each of the  $a_i$  by a factor  $\omega_i$  which represents the relative importance of this specific aberration to the overall image performance. In summary, the optical design target is to minimize the sum of the squares of the weighted aberrations  $a_i$  :

$$(\omega_1 a_1)^2 + (\omega_2 a_2)^2 + \dots + (\omega_I a_I)^2 \rightarrow \text{minimum}$$

Because the  $a_i$  are functions of the optical design parameters  $\rho_i$ , the sum of the weighted squares is also function of the  $\rho_i$ . And because this function, called  $\Phi$ , is a measure for the overall image performance, it is called a *merit function*. By using the usual short form for a summation " $\Sigma$ ", the optical design task can be put in a very compact form:

$$\Phi(\vec{\rho}) := \sum_{i=1}^I (w_i a_i(\vec{\rho}))^2 \longrightarrow \text{minimum}$$

As is known by those of ordinary skill, the following considerations must also be accounted for:



(1) There is an infinite number of light rays emerging from a finite object scenery, propagating through the optical system and finally forming the image. So, in theory, the aberration space is of infinite dimensionality, which is not manageable in practice. Therefore, the optical designer knows to select carefully a limited subset of rays - 10, 27, 56 . . . - whatever minimum number is necessary to be representative for all other light rays (and associated aberrations) which make up the image and are not taken into account.

Normally some of the aberrations are in conflict to each other: trying to improve one makes the other worse. The proper set of aberrations  $a_i$  (and associated weighting factors  $\omega_i$ ) as selected and specified by the optical designer as an input for an “automatic” optimization (i.e. minimization) computer program is a factor for design result.

(2) With the parameter space, e.g., with one single lens element, one is operating in a 6-dimensional space (see above), with two lenses in a 12-dimensional space, etc. However, if an appropriate starting system is known, this starting point can be utilized in the optimization process. If using a known computer program, the computer program needs a specific point in the parameter space to start at, i.e. the optical designer has to decide on a specific optical system layout as a *starting system* for the optimization program.

(3) Once the optical designer has selected a suitable set of aberrations  $a_i$  and a suitable set of weighting factors  $\omega_i$  and a suitable starting system, the designer can start the mathematics, e.g., via the optimization computer program. If everything is well prepared, the software will then find automatically a minimum of  $\Phi(\vec{\rho})$ . This may, however, be a local minimum.

(4) The optical designer can then apply manual changes to the merit function, i.e. to the set of aberrations to be corrected, and/or to the optical design parameters. In both cases this results mathematically in moving the system from one point in aberration space and/or parameter space to a different point - a point which the optimization program may not access by itself. This new point then becomes a new starting point for the minimization algorithm. An iterative process begins to determine then if the dependent variables have been correctly selected.

(5) Additionally, an optical designer can start "space hopping" by manipulating the optical system by changing some of the parameters, introducing additional parameters, or removing parameters.

In the way described above the optical designer proceeds in getting the aberrations better and better corrected and the overall image performance and general system performance into specifications. Thus, a skilled optical designer, in a step-by-step fashion, can design an optical system for a required need.

3. Teachings of the Specification

In combination with the above known physical laws and relationships, and the generally known techniques utilized by optical designers, the present specification further provides an optical designer with at least the following sufficient information from which to make the claimed invention:

- (1) the appropriate *starting system* (the claimed penultimate lens combination);
- (2) the desired applicability (a microscope objective for imaging DUV wavelengths, with example focal lengths and numerical aperture requirements);
- (3) seven different highly detailed (in terms of size, distance, focus, material, and spacings for all lenses) working recipes to design a microscope objective to focus DUV and IR wavelengths at the same focal point (see Figs. 5-8, and 20-22);
- (4) the desired wavelengths that are to be focussed to the same focal point;
- (5) example lens materials (e.g., quartz and fluorite materials);
- (6) image locus curves which involve a comparison between the image locus curves for the paraxial region and for full aperture (specification, page 3, ll. 16-19), whereby a good agreement between the image locus curves indicates good correction of spherical aberration (ll. 30-31) (see Figs. 9-12 and 23-25);
- (7) the observation concerning the size relationship among the outside radii of the lens elements (specification, page 4, lines 9-10); and
- (8) the observation that in optical design computing, the beam must not be modified smoothly at the penultimate element or the good correction and focus for the IR may be affected (specification, page 4, ll. 9-24).

Accordingly, applicant respectfully submits that the present application is fully enabling to a person of ordinary skill in the art. See MPEP 2164.01(b), which states: “As long as the specification discloses at least one method for making and using the claimed invention that bears a reasonable correlation to the entire scope of the claim, then the enablement requirement ... is satisfied.” (emphasis added, case citation omitted).

**Claim rejections under 35 USC § 103(a):**

Claims 1, 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over the patent issued to Hayashi (U.S. Patent No. 5,144,475). Claims 2, 3 and 5 are rejected under 35 U.S.C. 103(a) as being unpatentable over the patent issued to Hayashi as applied to claim 1 above, and further in view of the patent issued to Ono et al. (U.S. Patent No. 5,142,410). Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over the patent issued to Hayashi and Ono et al as applied to claim 2 above, and further in view of the patent issued to Shafer et al. (U.S. Patent No. 5,717,518). Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over the patent issued to Hayashi as applied to claim 1 above, and further in view of the patents issued to Ono et al and Shafer.

As no references were applied to claims 7-16, applicant assumes that the features of those claims are patentable over the art of record. The office action of January 10, 2002 did not address this argument, therefore the assumption is maintained.

Hayashi fails to teach or suggest each element of the invention as claimed in claim 1 or its dependent claims. First, applicant agrees with the Patent Office (see Office Action, page 6) that Hayashi fails to teach or suggest a microscope objective with an IR wavelength  $\lambda_{IR}$  at the same focal point as the DUV focus at  $\lambda_{DUV}$ . Hayashi fails to mention such a feature. As discussed above, the specification is enabling and provides seven working examples that provide a same focus at a DUV and an IR wavelength. As such, a prima facie case of obviousness has not been established.

Second, inherency has not been established by the patent office. Hayashi is silent as to focussing DUV and IR light at the same focus. Thus, the patent office guesses (see office action, page 3) that if chromatic aberration for a microscope objective can be minimized/eliminated, resulting in the same focus for DUV and IR light as claimed (and as

taught only in the present specification), using just quartz and fluorite lenses or a biconcave design, then the DUV/IR focus feature of the claimed invention is inherently met by Hayashi. However, regarding inherency, the “fact that a certain result may occur or be present in the prior art is not sufficient to establish the inherency of that result or characteristic.” MPEP 2112 (citations omitted). In *In re Rijckaert*, 3 F.3d 1531, 1534, 28 USPQ 1955 (Fed. Cir. 1993), the Federal Circuit reversed the Board’s rejection under obviousness based on an alleged inherent feature in the cited reference. The Federal Circuit stated: “That which may be inherent is not necessarily known. Obviousness cannot be predicated on what is unknown. Such a retrospective view of inherency is not a substitute for some teaching or suggestion supporting an obviousness rejection.” *Rijckaert*, 3 F.3d at 1534. (citations omitted). As discussed above, the DUV/IR focus feature of the claimed invention is a result of more than just a selection of quartz and fluorite materials or of a “biconcave” configuration of a particular lens. As such, the Patent Office has not established obviousness based on inherency in the Hayashi reference of the claimed features.

Third, the claimed invention of claim 1 is patentable over Hayashi due to secondary considerations, primarily unexpected results. The patent office admits that conventional expectations would lead one of skill in the art to believe that an objective cannot focus UV and IR light to the same focus. See Office Action, page 3 (“It is therefore expected that the focal point for the light of these very different wavelengths would be different”).

The specification directly addresses this unexpected result. On page 4 of the specification, second and third paragraphs, it is stated:

As a result of the size relationship according to the present invention among the outside radii, the imaging beam that up to that point has been slightly deflected by the preceding lenses or cemented groups is strongly refracted. This kind of beam deflection violates the rule ordinarily applied in optical computation that the beam must always be modified smoothly at each imaging element. For example, a sharp transition in the beam makes the objective highly sensitive to tolerances, so that an objective of this kind is difficult to produce or makes stringent demands in terms of production.

On the other hand, however, only with a penultimate element having this particular shape did it prove possible to achieve the same focus both for a region around a DUV wavelength  $\lambda_{\text{DUV}}$  and

for an IR wavelength  $\lambda_{IR}$ . If the relevant penultimate element is equipped, in an objective according to the present invention, with a moderate shape so that the previously deflected beam profile is smoothed again, then both the good correction and the focus for the IR wavelength  $\lambda_{IR}$  are lost.

Fourth, as discussed above, the specification teaches at least seven different objective configurations where the unexpected is the result. As Hayashi fails to teach or suggest a microscope objective that focuses DUV and IR light at the same focus, or even mention the possibility of using IR light, Hayashi cannot render obvious the claimed invention. As the applicant's previous remarks concerning unexpected results has not been addressed in the final office action, applicant continues to assert this secondary consideration.

Fifth, the patent office has not articulated any reason based on evidence as to why one of ordinary skill in the art would modify Hayashi to produce applicant's claimed microscope objective: there must be some motivation to modify the cited reference to produce applicant's invention. See e.g., *In re Dance*, 160 F.3d 1339, 1343, 48 USPQ2d 1635, 1637 (Fed. Cir. 1998) (there must be some motivation, suggestion, or teaching of the desirability of making the specific combination that was made by the applicant).

Concerning the rejections based on Hayashi combined with Ono and/or Shafer, claims 2-6 are patentable for at least the reasons discussed above. In addition, Ono is directed to endoscopes and Shafer is directed to a catadioptric imaging system. Applicant respectfully submits that these references would not be looked to by one of ordinary skill in the art to address the problem described in the present application or the claimed solution for the field of microscopes. Even if, *arguendo*, one of ordinary skill in the art would look to combine these secondary references with Hayashi, the resulting combination would not produce the claimed invention as neither Shafer nor Ono overcome the deficiencies of Hayashi.

With respect to claim 18, this claim is patentable over the art of record for at least the reasons stated above and additionally because Hayashi fails to teach or suggest a focal length of "1.6 mm or less," as claimed. In contrast, Hayashi teaches microscope objectives with focal lengths of 15 mm. See e.g., Hayashi, col. 6., line 65, col. 8, line 49, col. 12, line 7, and col. 13, line 32.

The combination of references fails to teach or suggest the microscope of claims 19 and 20 and the objective of claims 22-23 for at least the reasons discussed above. In addition, the combination of references fails to teach “an IR auto focus” (claim 19), the focal length of 1.6 mm or less (claims 20 and 22), and the same IR/DUV focal point for the objective (claim 23).

Accordingly, applicant respectfully submits that claims 1-20 and 22-23 are patentable over the references of record.

**Conclusion**

If applicant has not accounted for any fees required by this Amendment, the Commissioner is hereby authorized to charge to our Deposit Account No. 19-0741. A two MONTH petition for an extension of time is submitted herewith. If applicant have not accounted for a required extension of time under 37 C.F.R. § 1.136, that extension is requested and the corresponding fee should be charged to our Deposit Account.

The Examiner should feel free to contact the undersigned at (202) 672-5592, if there is anything the undersigned can do to assist the Examiner or expedite prosecution of the application.

Respectfully submitted,

Date 6/10/02

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**Version with Markings to Show Changes Made (Claims)**

1. (Twice Amended) A DUV-capable microscope objective, comprising:  
a lens group that comprises a plurality of lens elements [having] made of  
quartz glass and fluorite [compositions], wherein the objective has a DUV focus at a DUV  
wavelength,  $\lambda_{\text{DUV}} = 235 \text{ nm}$ , wherein the DUV focus encompasses a DUV wavelength  
region  $\lambda_{\text{DUV}} \pm \Delta\lambda$ , where  $\Delta\lambda = 8 \text{ nm}$ , wherein the objective has an IR focus for an IR  
wavelength  $\lambda_{\text{IR}} = 760 \text{ nm}$  at the same focal point as the DUV focus at  $\lambda_{\text{DUV}}$ , and wherein a  
penultimate lens element of the lens group comprises a concave configuration on both sides,  
wherein an object-side outer radius of the penultimate element is smaller than its image-side  
outer radius.

10. (Twice Amended) The objective as defined in Claim 7, wherein the  
[objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 248 \text{ nm} \pm 8$   
nm and an IR focus at  $\lambda_{\text{IR}} = 760 \text{ nm}$ .

11. (Twice Amended) The objective as defined in Claim 7, wherein the  
[objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 248 \text{ nm} \pm 8$   
nm and an IR focus at  $\lambda_{\text{IR}} = 825 \text{ nm}$ .

12. (Twice Amended) The objective as defined in Claim 7, wherein the  
[objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 248 \text{ nm} \pm 8$   
nm and an IR focus at  $\lambda_{\text{IR}} = 885 \text{ nm}$ .

13. (Twice Amended) The objective as defined in Claim 7, wherein the  
[objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 248 \text{ nm} \pm 8$   
nm and an IR focus at  $\lambda_{\text{IR}} = 905 \text{ nm}$ .



14. (Twice Amended) The objective as defined in Claim 8, wherein the [objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 266 \text{ nm} \pm 8 \text{ nm}$  and an IR focus at  $\lambda_{\text{IR}} = 780 \text{ nm}$ .

15. (Twice Amended) The objective as defined in Claim 7, wherein the [objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 266 \text{ nm} \pm 8 \text{ nm}$  and an IR focus at  $\lambda_{\text{IR}} = 785 \text{ nm}$ .

16. (Twice Amended) The objective as defined in Claim 8, wherein the [objective has a] DUV focus [in] includes a DUV wavelength region  $\lambda_{\text{DUV}} = 266 \text{ nm} \pm 8 \text{ nm}$  and an IR focus at  $\lambda_{\text{IR}} = 845 \text{ nm}$ .

19. (Amended) A DUV-capable microscope, comprising:  
an objective comprising a plurality of lens elements, wherein the objective has a DUV focus at a DUV wavelength,  $\lambda_{\text{DUV}} = 235 \text{ nm}$ , wherein the DUV focus encompasses a DUV wavelength region  $\lambda_{\text{DUV}} \pm \Delta\lambda$ , where  $\Delta\lambda = 8 \text{ nm}$ , wherein the objective has an IR focus for an IR wavelength  $\lambda_{\text{IR}} = 760 \text{ nm}$  at the same focal point as the DUV focus at  $\lambda_{\text{DUV}}$ , and wherein a penultimate lens element comprises a concave configuration on both sides, wherein an object-side outer radius of the penultimate element is smaller than its image-side outer radius; and

an IR laser autofocus system in optical communication with the objective to provide the IR wavelength  $\lambda_{\text{IR}}$  and auto-focussing.

22. (Amended) [The objective as defined in claim 21,] A microscope objective, comprising:

a converging first lens disposed closest to an object being imaged;

a converging second lens disposed along an optical axis after the first lens;

a first doublet lens disposed along the optical axis after the second lens;

a first triplet lens disposed along the optical axis after the first doublet lens;

a second triplet lens disposed along the optical axis after the first triplet lens;  
a converging lens group comprising one or more lenses disposed along the optical  
axis after the second triplet lens;  
a diverging penultimate lens comprising concave outer sides, wherein an object-side  
outer radius is smaller than an image-side outer radius disposed along the optical axis after  
the converging lens group; and  
a diverging doublet lens disposed after the penultimate lens,  
wherein the objective has a focal length of 1.6 mm or less at a DUV wavelength,  
 $\lambda_{\text{DUV}}$  235 nm, and an IR wavelength,  $\lambda_{\text{IR}}$  760 nm, and wherein a numerical aperture of  
the objective is at least 0.8.

23. (Amended) The objective as defined in claim [21] 22, wherein the  
objective has a DUV focus at a DUV wavelength,  $\lambda_{\text{DUV}}$  235 nm, wherein the DUV focus  
encompasses a DUV wavelength region  $\lambda_{\text{DUV}} \pm \Delta\lambda$ , where  $\Delta\lambda = 8$  nm, wherein the  
objective has an IR focus for an IR wavelength  $\lambda_{\text{IR}}$  760 nm at the same focal point as the  
DUV focus at  $\lambda_{\text{DUV}}$ .